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(54) OPERATION OF MULTIPLE INTERCONNECTED HYDRAULIC ACTUATORS IN A SUBTERRANEAN WELL

(71) Applicant: **HALLIBURTON ENERGY SERVICES, INC.**, Houston, TX (US)

(72) Inventor: **Joel D. Shaw**, Houston, TX (US)

(73) Assignee: **Halliburton Energy Services, Inc.**, Houston, TX (US)

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E21B 23/04 (2006.01)

(52) **U.S. Cl.**
CPC *E21B 34/06* (2013.01); *E21B 23/04* (2013.01)

(58) **Field of Classification Search**
USPC 166/373, 386, 319, 320, 321, 325
See application file for complete search history.

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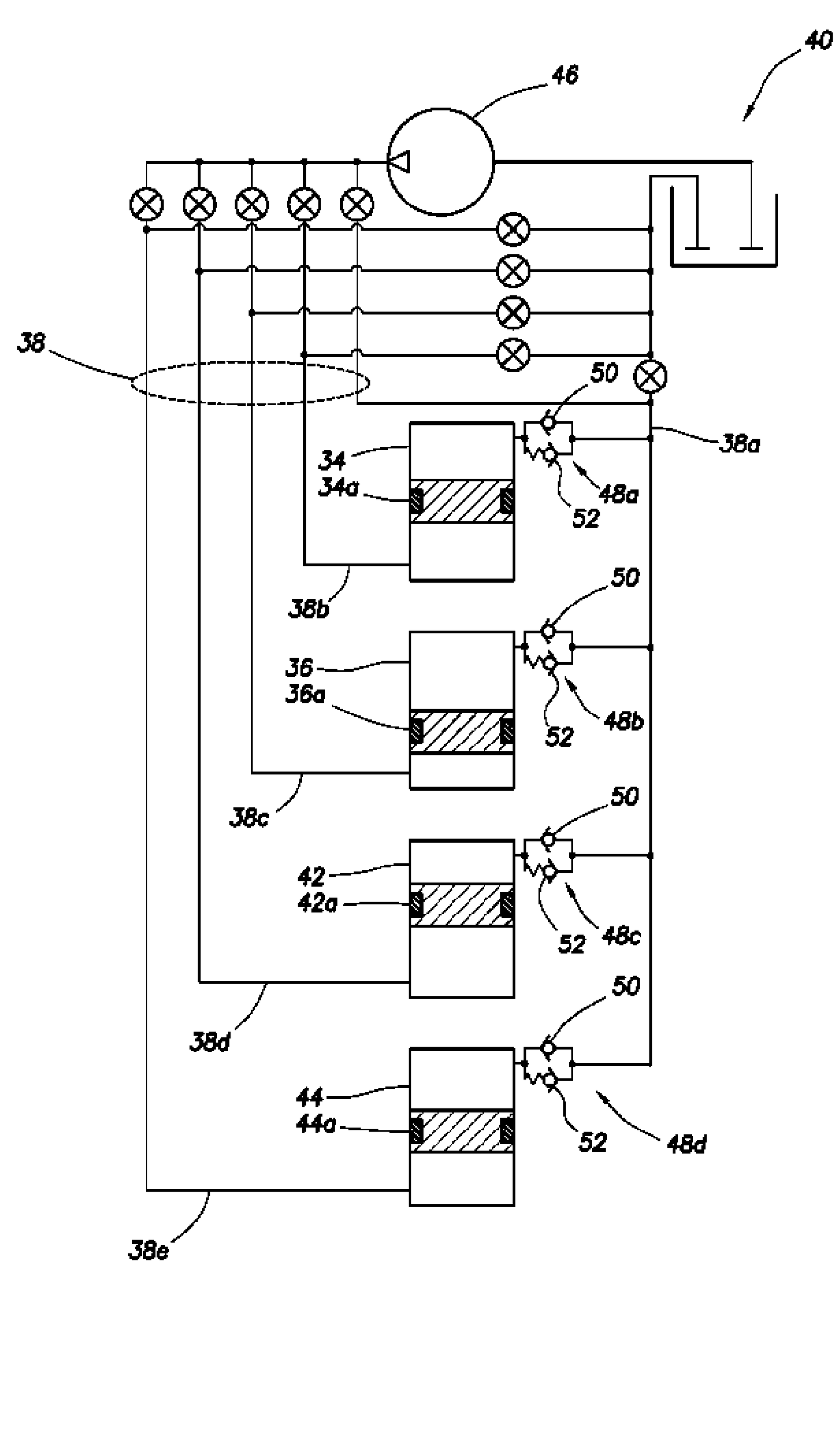
Primary Examiner — Sean Andrish
(74) *Attorney, Agent, or Firm* — Locke Lord LLP

(57) **ABSTRACT**

A system for use with a well can include multiple hydraulic actuators in the well, each of the actuators being connected to a common hydraulic line, and multiple pressure control devices, each pressure control device preventing flow from the hydraulic line to a respective one of the actuators unless a pressure differential across the pressure control device exceeds a predetermined level. A method of controlling operation of multiple hydraulic actuators in a well can include applying pressure to at least one of the actuators, thereby increasing pressure in a common hydraulic line connected to each of the actuators, preventing communication of the increased pressure in the common hydraulic line to additional actuators, and permitting flow from the common hydraulic line to each of the actuators, in response to a pressure differential across the pressure control devices exceeding a predetermined level.

20 Claims, 4 Drawing Sheets



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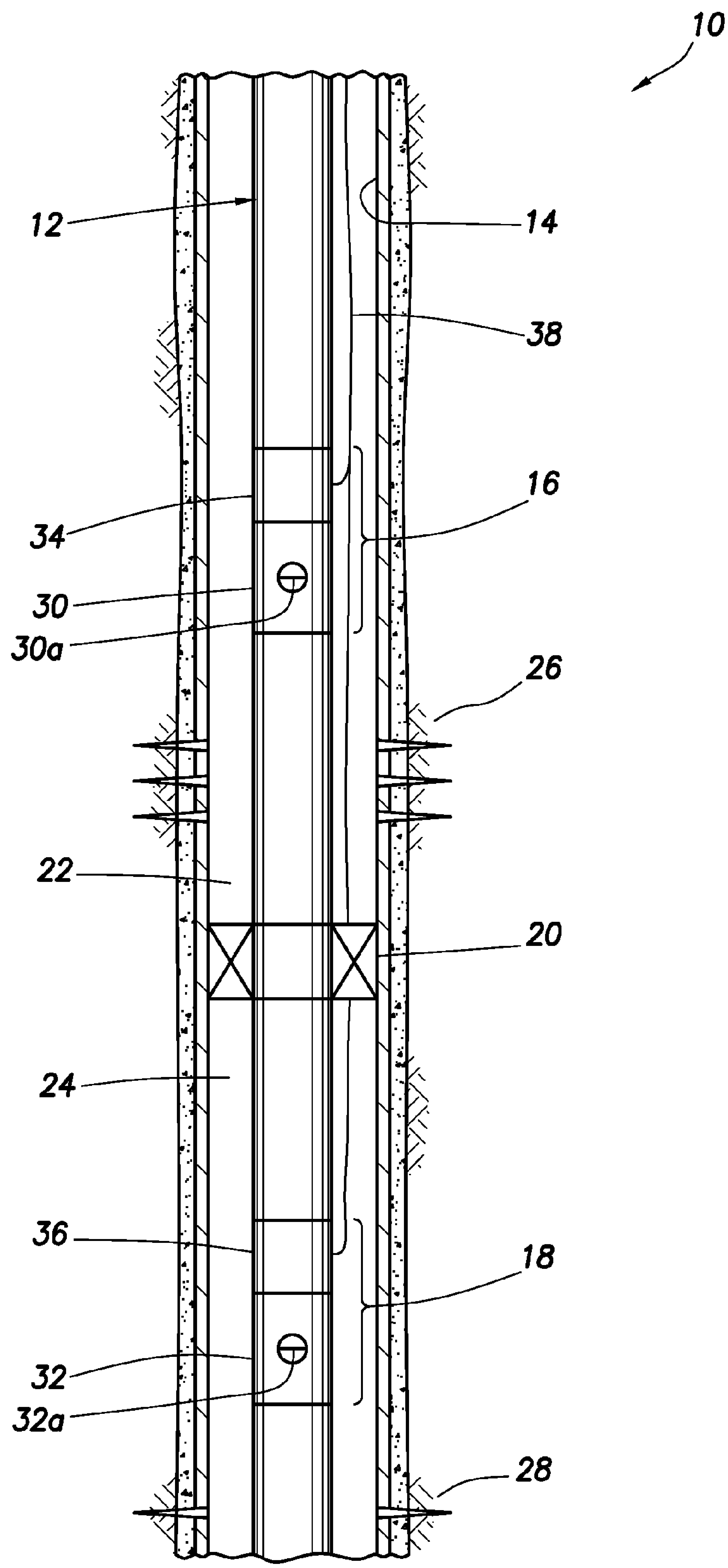

FIG. 1

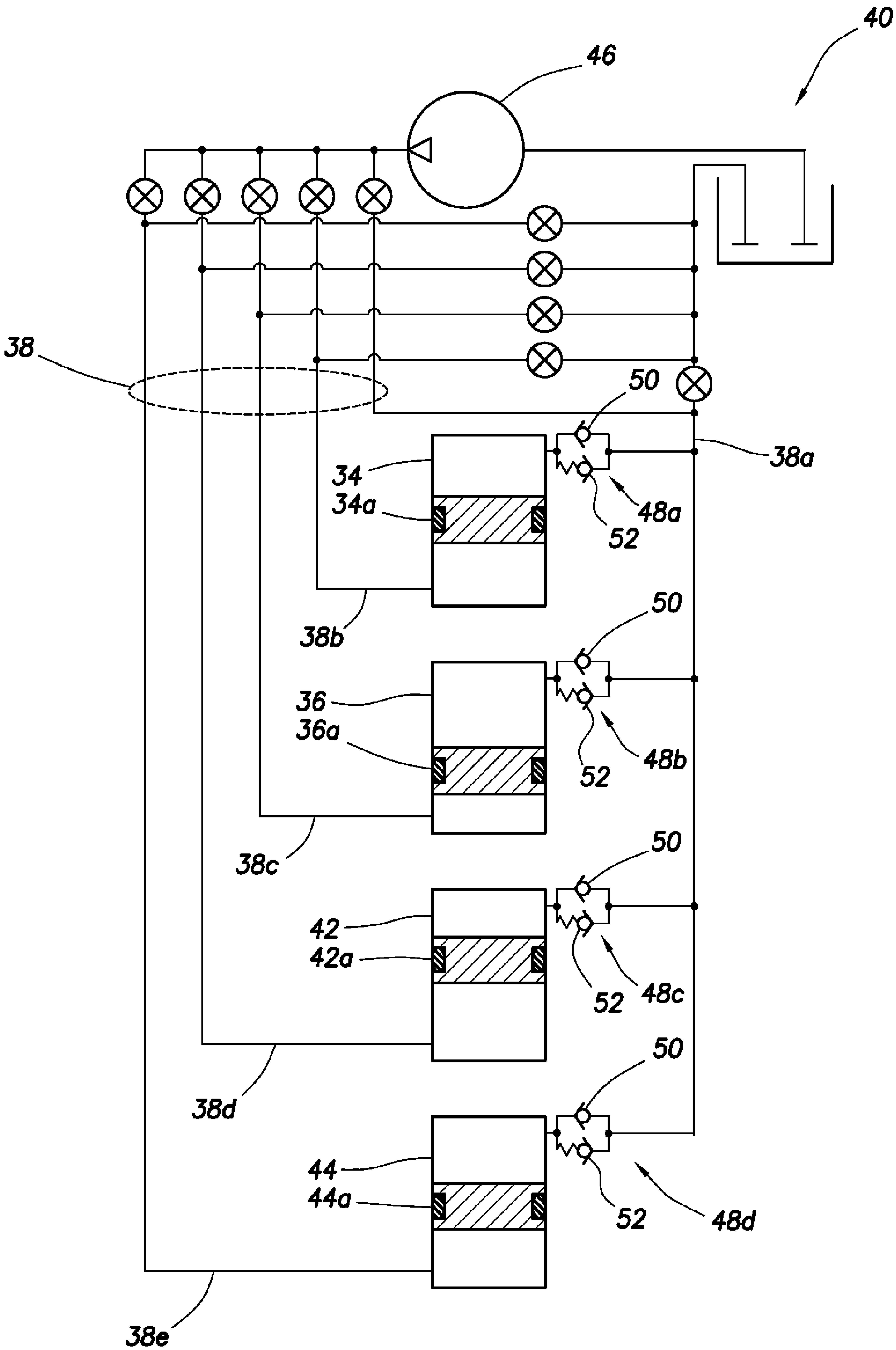
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FIG.2

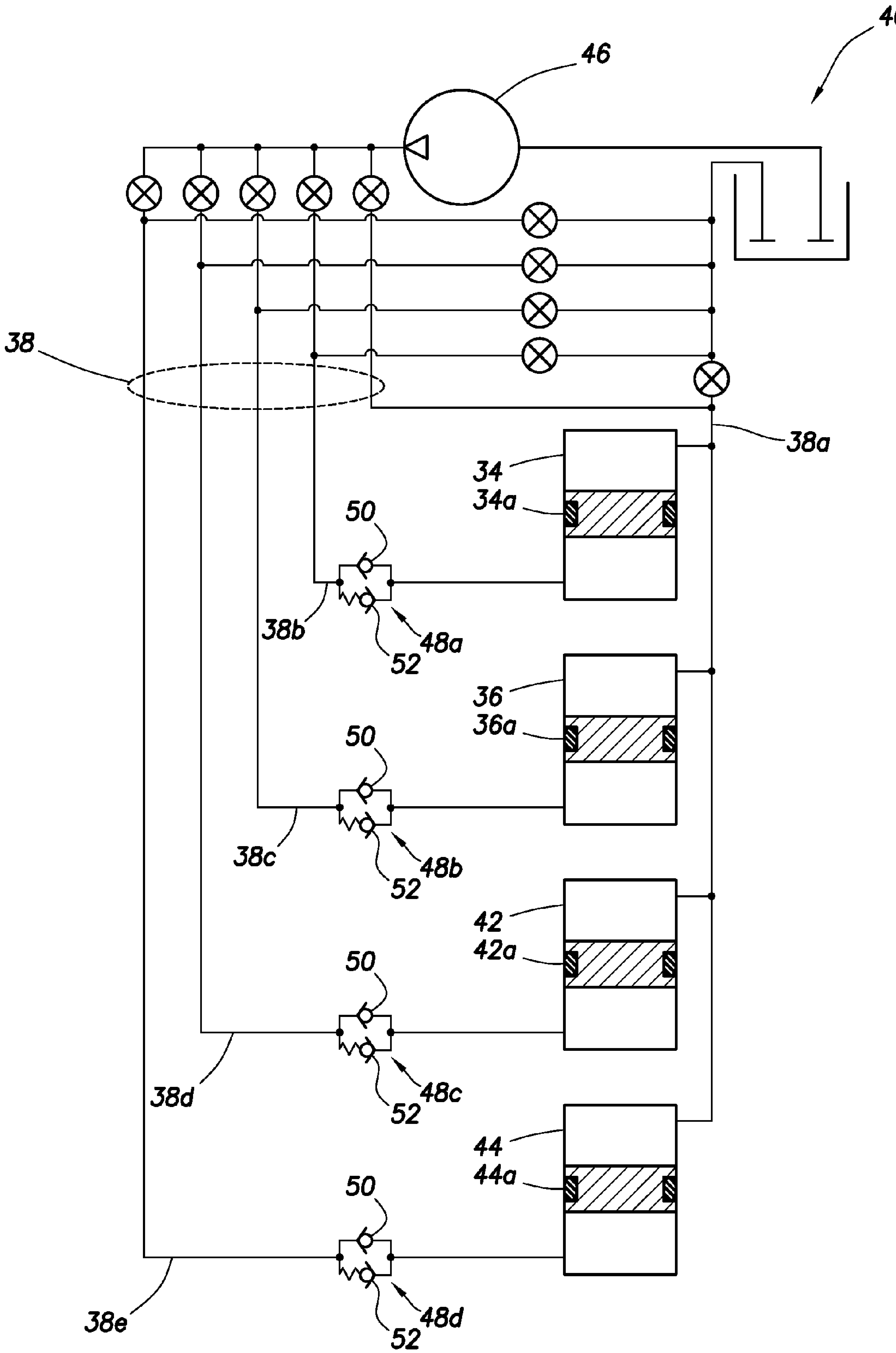
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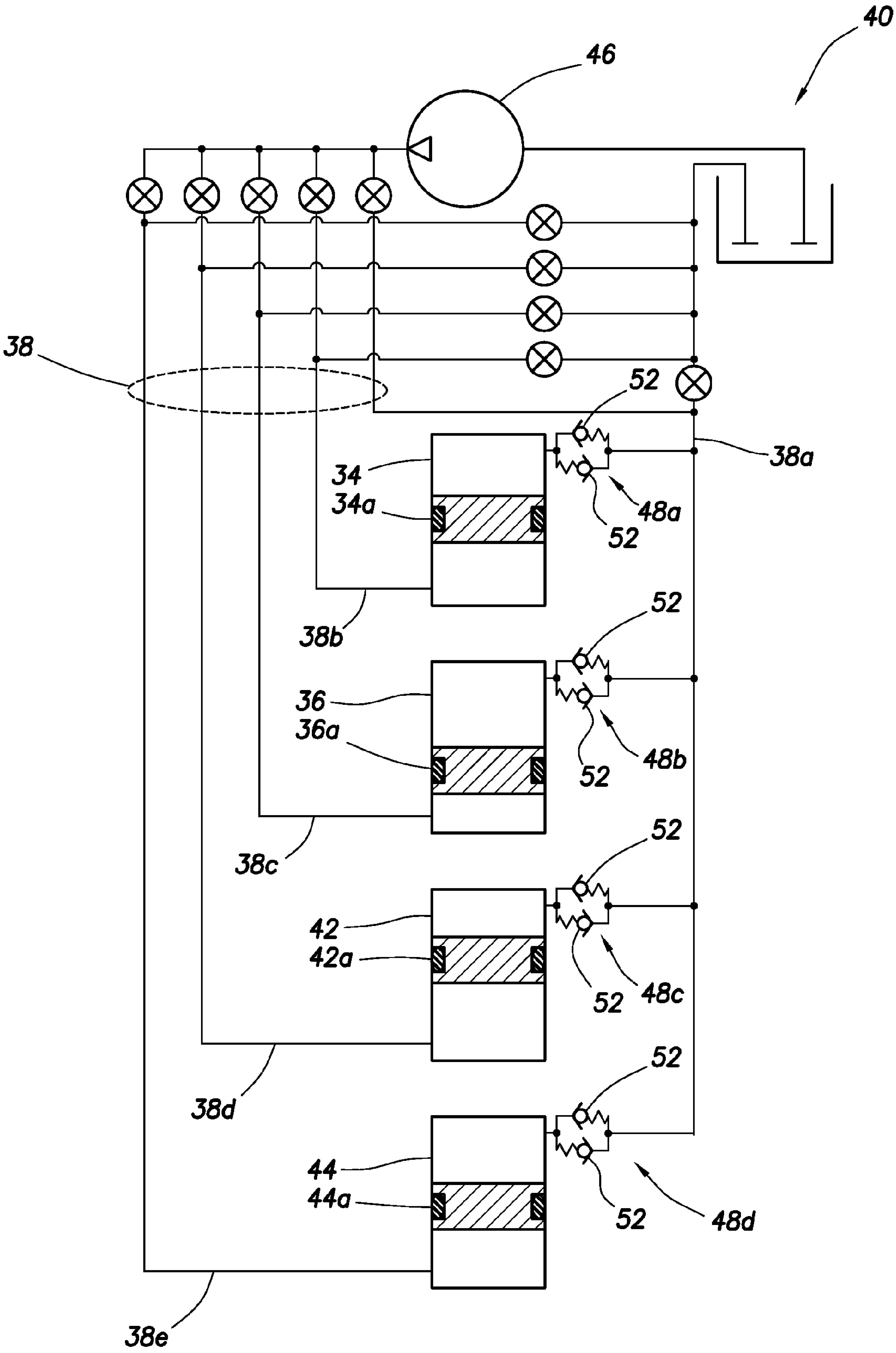
FIG.3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48d
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FIG. 4

OPERATION OF MULTIPLE INTERCONNECTED HYDRAULIC ACTUATORS IN A SUBTERRANEAN WELL

CROSS-REFERENCE TO RELATED APPLICATION

This application claims the benefit under 35 USC §119 of the filing date of International Application Serial No. PCT/US12/25677 filed 17 Feb. 2012. The entire disclosure of this prior application is incorporated herein by this reference.

BACKGROUND

This disclosure relates generally to equipment utilized and operations performed in conjunction with a subterranean well and, in one example described below, more particularly provides for operation of multiple interconnected hydraulic actuators in a well.

Hydraulic actuators have qualities (such as, low cost, reliability, effectiveness, etc.) which make them useful for operating well tools. However, as the number of downhole hydraulic actuators increases, it can be difficult to individually control the actuators, while also limiting a number of hydraulic lines used to deliver pressure to the actuators.

Therefore, it will be appreciated that improvements are continually needed in the art of controlling operation of multiple hydraulic actuators in a well.

SUMMARY

In this disclosure, systems and methods are provided which bring improvements to the art of actuating well tools with hydraulic actuators. An example is described below in which some actuators are prevented from operating inadvertently when another actuator is operated.

The disclosure below provides to the art a system for use with a subterranean well. In one example, the system can include multiple hydraulic actuators in the well, each of the actuators being connected to a common hydraulic line, and multiple pressure control devices, each pressure control device preventing flow from the hydraulic line to a respective one of the actuators unless a pressure differential across the pressure control device exceeds a predetermined level.

Also described below is a method of controlling operation of multiple hydraulic actuators in a subterranean well. In one example, the method can include: applying pressure to at least one of the actuators, thereby increasing pressure in a common hydraulic line connected to each of the actuators; preventing communication of the increased pressure in the common hydraulic line to additional ones of the actuators; and permitting flow from the common hydraulic line to each of the actuators, in response to a pressure differential across respective multiple pressure control devices exceeding a predetermined level.

A well tool control system is also described below. In one example, the system can include multiple hydraulic actuators, each of the actuators being connected to a common hydraulic line, and multiple pressure control devices, each pressure control device including a relief valve which prevents displacement of a piston of a respective one of the actuators unless a pressure differential across the pressure control device exceeds a predetermined level.

These and other features, advantages and benefits will become apparent to one of ordinary skill in the art upon careful consideration of the detailed description of representative embodiments of the disclosure hereinbelow and the accompanying drawings, in which similar elements are indicated in the various figures using the same reference numbers.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a representative partially cross-sectional view of a well system and associated method which can embody principles of this disclosure.

FIG. **2** is a representative schematic view of a well tool control system which may be used in the system and method of FIG. **1**, and which can embody the principles of this disclosure.

FIGS. **3** & **4** are representative schematic views of additional examples of the well tool control system.

DETAILED DESCRIPTION

Representatively illustrated in FIG. **1** is a system **10** for use with a subterranean well, and an associated method, which can embody principles of this disclosure. However, it should be clearly understood that the system **10** and method are merely one example of an application of the principles of this disclosure in practice, and a wide variety of other examples are possible. Therefore, the scope of this disclosure is not limited at all to the details of the system **10** and method described herein and/or depicted in the drawings.

In the FIG. **1** example, a tubular string **12** is positioned in a wellbore **14**. Interconnected in the tubular string **12** are well tools **16**, **18** and a packer **20** which isolates an upper annulus **22** from a lower annulus **24**.

The upper annulus **22** is in communication with a formation interval or zone **26**, and the lower annulus **24** is in communication with another interval or zone **28**. The well tool **16** is used to control flow between the zone **26** and an interior of the tubular string **12** via the upper annulus **22**, and the well tool **18** is used to control flow between the zone **28** and the interior of the tubular string via the lower annulus **24**.

The well tools **16**, **18** and the packer **20** are merely examples of well tools which can incorporate the principles of this disclosure. It should be clearly understood that actuation of well tools other than flow control tools and packers may be improved, without departing from the scope of this disclosure. Although only two well tools **16**, **18** and the packer **20** are depicted in FIG. **1**, actuation of any number of well tools can be controlled using the principles of this disclosure.

The well tools **16**, **18** include respective flow control devices **30**, **32**. Each of the flow control devices **30**, **32** is used to selectively permit or prevent flow between the interior of the tubular string **12** and the respective annuli **22**, **24** (and, therefore, the respective zones **26**, **28**). Closure devices **30*a***, **32*a*** of the respective flow control devices **30**, **32** are used, in this example, to selectively block or choke flow between the tubular string **12** interior and the respective annuli **22**, **24**.

The flow control devices **30**, **32** can be of the types known to those skilled in the art as production valves, downhole chokes, interval control valves, etc. The flow control devices **30**, **32** can variably restrict flow, for example, by positioning the respective closure devices **30*a***, **32*a*** between their fully open and fully closed positions.

The well tools **16**, **18** also include respective actuators **34**, **36** for operating the respective flow control devices **30**, **32**. The actuators **34**, **36** are hydraulic actuators which actuate in response to pressure in hydraulic lines **38** extending to the actuators from a remote location (such as, the surface, a subsea facility, a floating platform, etc.), as described more fully below.

It is desirable to be able to individually actuate the actuators **34**, **36** in order to individually operate the flow control devices **30**, **32**. For example, it may be desired to allow more flow through the flow control device **30** as compared to the flow control device **32** at times, and vice versa. Furthermore, the amount of flow to be permitted through each flow control device **30**, **32** can change over time, and so the ability to separately operate the flow control devices is very beneficial.

Another desire is to reduce the number of hydraulic lines **38** installed. Installation of hydraulic lines can be expensive and time-consuming, and the lines can become damaged during installation or thereafter. Although the lines **38** are depicted in FIG. **1** as being external to the tubular string **12**, they could in other examples be internal to the tubular string, or they could extend through a wall of the tubular string.

Although the tubular string **12** is depicted in FIG. **1** as being a production or injection string, in other examples the tubular string could be another type of string. For example, the tubular string **12** could be a casing string, liner string, completion string, testing string, or any other type of string.

Referring additionally now to FIG. **2**, a system **40** for controlling operation of well tools is representatively illustrated in schematic form. The system **40** may be used in the well system **10** of FIG. **1** for controlling operation of the well tools **16**, **18**, or the system **40** may be used in other well systems and methods.

Four hydraulic actuators **34**, **36**, **42**, **44** are depicted in the FIG. **2** example, two of which are used in the system **10** of FIG. **1** for actuating the well tools **16**, **18**. The additional two actuators **42**, **44** may also be used for actuating flow control devices or any other type of well tools. Any number of actuators may be used in keeping with the scope of this disclosure.

Two hydraulic lines could be connected to each actuator **34**, **36**, **42**, **44** in order to displace respective pistons **34***a*, **36***a*, **42***a*, **44***a* in each of two respective opposite directions. However, to reduce the number of lines **38** extending in the wellbore **14**, a common line **38***a* is connected to each of the actuators **34**, **36**, **42**, **44**.

In the FIG. **2** example, pressure can be applied to the common line **38***a* (e.g., using a pump **46** or another pressure source positioned at a remote location) to thereby displace all of the pistons **34***a*, **36***a*, **42***a*, **44***a* downward (as viewed in FIG. **2**). This capability can be used to "reset" all of the actuators **34**, **36**, **42**, **44** to a known position.

For example, in the system **10** of FIG. **1**, pressure could be applied to the common line **38***a* to close all of the flow control devices **30**, **32**. The pistons **34***a*, **36***a* in this example could be connected to the respective closure devices **30***a*, **32***a* of the flow control devices **30**, **32**. Similar closure devices could be connected to the other pistons **42***a*, **44***a*.

Pressure can be applied to one of the other lines **38***b-e* to displace a respective one of the pistons **34***a*, **36***a*, **42***a*, **44***a* upward. A certain volume of hydraulic fluid can be discharged from one of the lines **38***b-e* into the respective one of the actuators **34**, **36**, **42**, **44** to produce a corresponding amount of displacement of the respective one of the pistons **34***a*, **36***a*, **42***a*, **44***a*. This capability can be used to set each individual flow control device at a respective desired position to permit a corresponding amount of production or injection flow.

Note that, when fluid is discharged from one of the lines **38***b-e* into its respective one of the actuators **34**, **36**, **42**, **44**, a corresponding amount of fluid is discharged from the actuator to the common line **38***a*. In many practical applications, however, the common line **38***a* will have a fairly small flow area and will extend thousands of meters (perhaps a mile or more) from the remote location to the actuators **34**, **36**, **42**, **44**.

As a result, pressure in the common line **38***a* can increase when pressure is applied to one of the actuators **34**, **36**, **42**, **44** via a respective one of the lines **38***b-e*. To prevent this pressure increase in the common line **38***a* from affecting the positions of the other pistons (the pistons not corresponding to the one of the lines **38***b-e* to which pressure was applied), the system **40** includes pressure control devices **48***a-d* interconnected between the common line and the respective actuators **34**, **36**, **42**, **44**.

In the FIG. **2** example, each of the pressure control devices **48***a-d* includes a check valve **50** and a relief valve **52**. The check valve **50** and relief valve **52** are preferably connected in parallel, as depicted in FIG. **2**.

The check valve **50** permits relatively unrestricted flow from an actuator to the common line **38***a*. Thus, when pressure is applied to one of the lines **38***b-d*, the respective one of the pistons **34***a*, **36***a*, **42***a*, **44***a* can displace as desired, and fluid will be readily discharged from the respective one of the actuators **34**, **36**, **42**, **44** to the common line **38***a*.

However, a pressure increase in the common line **38***a* will not be communicated to any of the actuators **34**, **36**, **42**, **44** unless a pressure differential across the respective relief valve **52** is greater than a predetermined level. For example, the relief valves **52** could be set to open at a pressure differential of 10.3 MPa (~1500 psi), so that an inadvertent increase in pressure in the common line **38***a* will not cause unintended displacement of any of the pistons **34***a*, **36***a*, **42***a*, **44***a*.

Pressure can be applied to the common line **38***a* when desired to displace all of the pistons **34***a*, **36***a*, **42***a*, **44***a* (for example, to "reset" all of the actuators **34**, **36**, **42**, **44**), and that pressure will be communicated to all of the actuators when the pressure differential across the relief valves **52** exceeds the predetermined level. Note that it is not necessary for all of the relief valves **52** to open at the same time, or for all of the relief valves to have the same opening differential pressure.

It is contemplated that the predetermined pressure differential level in most practical applications will be about 6.9-17.2 MPa (~1000-2500 psi), but other levels may be used as desired. In general, it is expected that the level should increase with increasing depth, but this is not necessary and a number of factors (e.g., length of the line **38***a*, flow area in the line, temperature, type of hydraulic fluid, etc.) can influence the value of the predetermined pressure differential level.

Although in FIG. **2** the pressure control devices **48***a-d* are depicted as including separate check valves **50** and relief valves **52**, in other examples more or less components may be included in the pressure control devices, and the check valves and relief valves could be combined. A suitable combined check and relief valve is marketed by Lee Co. of Westbrook, Conn. USA (e.g., a Lee P.R.I./Chek Combination Valve).

Referring additionally now to FIG. **3**, another example of the control system **40** is representatively illustrated. In this example, the pressure control devices **48***a-d* are connected between the actuators **34**, **36**, **42**, **44** and the respective lines **38***b-e*.

It will be appreciated by those skilled in the art that the system **40** configuration of FIG. **3** will operate essentially the same as the configuration of FIG. **2**. One difference is that, when applying pressure to the actuators **34**, **36**, **42**, **44** from the common line **38***a*, the increased pressure will be transmitted by the pistons **34***a*, **36***a*, **42***a*, **44***a* to the pressure control devices **48***a-d*.

In another example, the pressure control devices **48***a-d* could be connected both: a) between the common line **38***a* and the respective actuators **34**, **36**, **42**, **44** (as in the FIG. **2** example), and b) between the actuators and the respective lines **38***b-e* (as in the example of FIG. **3**). Thus, various combinations and arrangements of components may be used, in keeping with the scope of this disclosure.

Referring additionally now to FIG. **4**, another example of the control system **40** is representatively illustrated. In this example, the check valves **50** are replaced by relief valves **52** in the pressure control devices **48***a-d*.

To displace any of the pistons **34***a*, **36***a*, **42***a*, **44***a* upward (as viewed in FIG. **4**), sufficient pressure must be applied to the respective line **38***b-e* to open the upper relief valve in the respective pressure control device **48***a-d*. For example, a pressure differential from the respective line **38***b-e* to the common line **38***a* must exceed an opening pressure of the upper relief valve **52** in the respective pressure control device **48***a-d*.

Note that this arrangement (oppositely directed relief valves **52** connected in parallel) may be used in the FIGS. **2** & **3** examples, as well. The pressure control devices **48***a-d* of FIG. **4** may be connected on either side of the actuators **34**, **36**, **42**, **44**. It is not necessary for the relief valves **52** in a pressure control device to open at the same differential pressure level.

It can now be fully appreciated that the above disclosure provides significant advancements to the art of controlling operation of multiple hydraulic actuators in a well. In the system **40**, the number of hydraulic lines **38** is reduced by using a common line **38***a* connected to each of the actuators **34**, **36**, **42**, **44**, and inadvertent actuation of the actuators is avoided by interconnecting the pressure control devices **48***a-d* between the common line and the respective actuators.

A system **10** for use with a subterranean well is described above. In one example, the system **10** comprises multiple hydraulic actuators **34**, **36**, **42**, **44** in the well, each of the actuators **34**, **36**, **42**, **44** being connected to a common hydraulic line **38***a*, and multiple pressure control devices **48***a-d*, each pressure control device **48***a-d* preventing flow from the hydraulic line **38***a* to a respective one of the actuators **34**, **36**, **42**, **44** unless a pressure differential across the pressure control device **48***a-d* exceeds a predetermined level.

Each pressure control device **48***a-d* may permit flow from the hydraulic line **38***a* to the respective one of the actuators **34**, **36**, **42**, **44** in response to the pressure differential being greater than the predetermined level.

The pressure control devices **48***a-d* can permit flow from the actuators **34**, **36**, **42**, **44** to the hydraulic line **38***a*.

Each pressure control device **48***a-d* may include a relief valve **52** which opens at the predetermined pressure differential level.

Each pressure control device **48***a-d* may include a check valve **50** which prevents flow through the check valve **50** from the hydraulic line **38***a* to the respective one of the actuators **34**, **36**, **42**, **44**. A relief valve **52** can be connected in parallel with the check valve **50**.

The system **10** can also include multiple flow control devices **30**, **32** which selectively control flow between an interior and an exterior of a tubular string **12**. Each of the actuators **34**, **36** can actuate a respective one of the flow control devices **30**, **32**.

Also described above is a method of controlling operation of multiple hydraulic actuators **34**, **36**, **42**, **44** in a subterranean well. In one example, the method comprises: applying pressure to at least one of the actuators **34**, **36**, **42**, **44**, thereby increasing pressure in a common hydraulic line **38***a* connected to each of the actuators **34**, **36**, **42**, **44**; preventing communication of the increased pressure in the common hydraulic line **38***a* to additional ones of the actuators **34**, **36**, **42**, **44**; and permitting communication between the common hydraulic line **38***a* and each of the actuators **34**, **36**, **42**, **44**, in response to a pressure differential across multiple respective pressure control devices **48***a-d* exceeding a predetermined level.

The method can also include connecting the pressure control devices **48***a-d* between the common hydraulic line **38***a* and the actuators **34**, **36**, **42**, **44**, each pressure control device **48***a-d* preventing displacement of a piston **34***a*, **36***a*, **42***a*, **44***a* of a respective one of the actuators **34**, **36**, **42**, **44** unless the pressure differential from the hydraulic line **38***a* to the respective one of the actuators **34**, **36**, **42**, **44** exceeds the predetermined level.

A well tool control system **10** is also described above. In one example, the control system **10** comprises multiple hydraulic actuators **34**, **36**, **42**, **44**, each of the actuators **34**, **36**, **42**, **44** being connected to a common hydraulic line **38***a*, and multiple pressure control devices **48***a-d*, each pressure control device **48***a-d* including a relief valve **52** which prevents displacement of a piston **34***a*, **36***a*, **42***a*, **44***a* of a respective one of the actuators **34**, **36**, **42**, **44** unless a pressure differential across the pressure control device exceeds a predetermined level.

Although various examples have been described above, with each example having certain features, it should be understood that it is not necessary for a particular feature of one example to be used exclusively with that example. Instead, any of the features described above and/or depicted in the drawings can be combined with any of the examples, in addition to or in substitution for any of the other features of those examples. One example's features are not mutually exclusive to another example's features. Instead, the scope of this disclosure encompasses any combination of any of the features.

Although each example described above includes a certain combination of features, it should be understood that it is not necessary for all features of an example to be used. Instead, any of the features described above can be used, without any other particular feature or features also being used.

It should be understood that the various embodiments described herein may be utilized in various orientations, such as inclined, inverted, horizontal, vertical, etc., and in various configurations, without departing from the principles of this disclosure. The embodiments are described merely as examples of useful applications of the principles of the disclosure, which is not limited to any specific details of these embodiments.

In the above description of the representative examples, directional terms (such as "above," "below," "upper," "lower," etc.) are used for convenience in referring to the accompanying drawings. However, it should be clearly understood that the scope of this disclosure is not limited to any particular directions described herein.

The terms "including," "includes," "comprising," "comprises," and similar terms are used in a non-limiting sense in this specification. For example, if a system, method, apparatus, device, etc., is described as "including" a certain feature or element, the system, method, apparatus, device, etc., can include that feature or element, and can also include other features or elements. Similarly, the term "comprises" is considered to mean "comprises, but is not limited to."

Of course, a person skilled in the art would, upon a careful consideration of the above description of representative embodiments of the disclosure, readily appreciate that many modifications, additions, substitutions, deletions, and other changes may be made to the specific embodiments, and such changes are contemplated by the principles of this disclosure. For example, structures disclosed as being separately formed can, in other examples, be integrally formed and vice versa. Accordingly, the foregoing detailed description is to be clearly understood as being given by way of illustration and example only, the spirit and scope of the invention being limited solely by the appended claims and their equivalents.

What is claimed is:

1. A system for use with a subterranean well, the system comprising:

a plurality of hydraulic actuators in the well, all of the actuators being hydraulically connected to a common hydraulic line, and each of the actuators being hydraulically connected to a different one of a plurality of dedicated hydraulic lines, wherein each dedicated hydraulic line only operates a respective one of the actuators to which the dedicated hydraulic line is hydraulically connected, wherein each of the plurality of actuators is only hydraulically connected to the common hydraulic line and one of the plurality of dedicated hydraulic lines such that each actuator is only connected to two hydraulic lines, wherein a common line shutoff valve is operatively connected between the common line and a pump, wherein a dedicated line shutoff valve is operatively connected to each dedicated hydraulic line between each of the actuators and the pump; and

a plurality of pressure control devices, each pressure control device preventing flow from the common hydraulic line to a respective one of the actuators unless a pressure differential across the respective pressure control device exceeds a predetermined level, whereby all of the hydraulic actuators can all be reset to a known position by applying pressure to the common hydraulic line, wherein pressure will be communicated to all of the actuators when the pressure differential across the pressure control devices exceeds the predetermined level.

2. The system of claim **1**, wherein each pressure control device permits flow from the common hydraulic line to the respective one of the actuators in response to the pressure differential being greater than the predetermined level.

3. The system of claim **1**, wherein the pressure control devices permit flow from the actuators to the common hydraulic line.

4. The system of claim **1**, wherein each pressure control device includes a relief valve which opens at the predetermined pressure differential level.

5. The system of claim **1**, wherein each pressure control device includes a check valve which prevents flow through the check valve from the common hydraulic line to the respective one of the actuators.

6. The system of claim **5**, wherein each pressure control device includes a relief valve connected in parallel with the check valve.

7. The system of claim **1**, further comprising multiple flow control devices which selectively control flow between an interior and an exterior of a tubular string, and wherein each of the actuators actuates a respective one of the flow control devices.

8. A method of controlling operation of multiple hydraulic actuators in a subterranean well, the method comprising:

hydraulically connecting each of the hydraulic actuators to only a common hydraulic line and a dedicated hydraulic line such that each actuator is only connected to two hydraulic lines;

applying pressure to one of the actuators via the dedicated hydraulic line which only operates the one of the actuators to which the dedicated hydraulic line is hydraulically connected, thereby increasing pressure in the common hydraulic line which is hydraulically connected to all of the actuators;

preventing communication of the increased pressure in the common hydraulic line to additional ones of the actuators; and

permitting flow from the common hydraulic line to all of the actuators, in response to a pressure differential across all of the respective pressure control devices exceeding a predetermined level, thereby resetting all of the actuators to a known position, wherein a dedicated line shutoff valve is operatively connected to each dedicated hydraulic line between a pump and an actuator of the multiple hydraulic actuators, wherein a common line shutoff valve is operatively connected between the common line and the pump, and wherein permitting flow from the common hydraulic line to all of the actuators includes opening the common line shutoff valve and closing all of the dedicated line shutoff valves.

9. The method of claim **8**, further comprising connecting the multiple pressure control devices between the common hydraulic line and the actuators, each pressure control device preventing flow from the common hydraulic line to a respective one of the actuators unless the pressure differential from the common hydraulic line to the respective one of the actuators exceeds the predetermined level.

10. The method of claim **8**, wherein each pressure control device permits displacement of a piston of each of the actuators in response to the pressure differential being greater than the predetermined level.

11. The method of claim **8**, wherein the pressure control devices permit flow from the actuators to the common hydraulic line.

12. The method of claim **8**, wherein each pressure control device includes a relief valve which opens at the predetermined pressure differential level.

13. The method of claim **8**, wherein each pressure control device includes a check valve which prevents flow from the common hydraulic line to the respective one of the actuators.

14. The method of claim **13**, wherein each pressure control device includes a relief valve connected in parallel with the respective check valve.

15. The method of claim **8**, wherein multiple flow control devices selectively control flow between an interior and an exterior of a tubular string, and wherein each of the actuators actuates a respective one of the flow control devices.

16. A well tool control system, comprising:

a plurality of hydraulic actuators, all of the actuators being hydraulically connected to a common hydraulic line, and each of the actuators being hydraulically connected to a dedicated different one of a plurality of dedicated hydraulic lines, wherein each dedicated hydraulic line only operates a respective one of the actuators to which the dedicated hydraulic line is hydraulically connected, wherein each of the plurality of actuators is only hydraulically connected to the common hydraulic line and one of the plurality of dedicated hydraulic lines such that each actuator is only connected to two hydraulic lines, wherein a common line shutoff valve is operatively connected between the common line and a pump, and wherein a dedicated line shutoff valve is operatively connected to each dedicated hydraulic line between each of the actuators and the pump; and

a plurality of pressure control devices, each pressure control device including a relief valve which prevents displacement of a piston of each of the actuators unless a pressure differential across the pressure control device exceeds a predetermined level, whereby all of the hydraulic actuators can all be reset to a known position by applying pressure to the common hydraulic line, wherein pressure will be communicated to all of the actuators when the pressure differential across the pressure control devices exceeds the predetermined level.

17. The system of claim **16**, wherein the pressure control devices permit flow from the actuators to the common hydraulic line.

18. The system of claim **16**, wherein each pressure control device includes a check valve which prevents flow from the common hydraulic line to the respective one of the actuators.

19. The system of claim **18**, wherein the relief valve is connected in parallel with the check valve in each of the pressure control devices.

20. The system of claim **16**, further comprising multiple flow control devices which selectively control flow between an interior and an exterior of a tubular string, and wherein each of the actuators actuates a respective one of the flow control devices.

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